International Journal of Engineering Management and Life Sciences (IJEMLS)
Volume: 01 Issue: 01 | June-2016 www.ijemls.com

Comparative Analysis of Wavelet Based Constant Envelope OFDM and Constant Envelope OFDM Using Phase Modulation

Rafik Ahmad, Shashank Kumar Dubey

Babu Banarasi Das Northern India Institute of Technology, BBD University, Lucknow-226020, Uttar Pradesh, India

Abstract

Orthogonal frequency division multiplexing (OFDM) is a popular modulation technique for wireless digital communication. OFDM is a multicarrier system that provides an efficient way to handle the high speed data in multipath fading environment. In this paper we study the suitability of constant envelope multicarrier modulation Technique. This technique combines orthogonal frequency division multiplexing and phase modulation.
A new PAPR mitigation technique is presented. In constant envelope OFDM the high PAPR OFDM signal is transformed into 0db PAPR by way of phase modulation. CE-OFDM implementation uses fourier filters via inverse discrete fourier transform (IDFT) and discrete fourier transform (DFT). Many researchers suggest that the wavelet is a good platform for CE-OFDM. In this paper we shown that the comparison between DFT based CE-OFDM With phase modulation and DWT based CE-OFDM with phase modulation .In this paper we also explore the more detail of CE-OFDM and DWT-CEOFDM regarding power spectral density ,BER analysis and spectral analysis. By way of Matlab simulation DWT-CEOFDM is compare with CE-OFDM.

Key Words: **Wavelet trans form, CE-OFDM SYSTEM, PAPR**

INTRODUCTION

Multicarrier modulation technique such as orthogonal frequency division multiplexing (OFDM) technique is a wideband technique for digital wireless communication [1]. In Multicarrier modulation technique the input data is divided into different frequency bands on which modulation is performed and multiplexed at different carrier frequency, so the information is transmitted on each subcarrier [2]. By multiplexing *N* data-modulated subcarriers, the OFDM signal has high amplitude fluctuation which produces a large peak-to-average power ratio (PAPR) [3]. Many techniques have been developed for PAPR problem. Pre-distortion techniques such as clipping and filtering, peak windowing, peak cancellation have been studied [4]. In order to eliminate PAPR, researchers have also developed other modified OFDM formats by modulating the OFDM waveform into the frequency or the phase of a single-carrier signal. Due to the use of phase or frequency modulation, these formats results in constant-envelope signals that provide a unity PAPR (0db). In this the OFDM waveform is transformed in to 0db peak to average power ratio. The signal transformation technique that converts the variations in the peak power and average power to a constant envelope signal, hence it is called as constant envelope OFDM (CE-OFDM) system [5-10]. In CE-OFDM system the OFDM signal is transformed with phase modulation, a signal designed for efficient power amplification.at the receiver side the phase demodulation is applied prior to conventional OFDM demodulator. The main difference between OFDM and CE-OFDM is that the signal transformation is done through phase modulation and phase demodulation.

In FFT based OFDM and CE-OFDM system the cyclic prefix is added before transmitting the signal through the channel to avoiding ISI and ICI. This cyclic prefix will take the 25% Bandwidth, To improve bandwidth performance ,ISI,ICI the DWT-OFDM system was proposed .The wavelet based system has an stronger ability to suppress the ISI and ICI than the conventional OFDM and CE-OFDM system [11].

Recently, it was found that based on Haar-orthonormal wavelets, discrete wavelet based CEOFDM (DWT-CEOFDM) is capable of reducing the inter symbol interference (ISI) and ICI, which are caused by the loss in orthogonality between the carriers. DWT-CEOFDM can also support much higher spectrum efficiency than discrete Fourier-based OFDM (DFTCEOFDM). The DFT-CEOFDM is replaced by DWT-CEOFDM in order to further reduce the level of interference and increase spectral efficiency. In this paper we have addressed the following keys issue of CE-OFDM-pm and DWT-CEOFDM-PM, Spectral analysis and BER analysis.

In Methodology section I we described the system description of FFT Based CE-OFDM-PM. In section II we describe DWT CE-OFDM–PM. In results section we have described the BER analysis, spectral analysis of FFT based CE-OFDM-PM and DWT CE-OFDM-PM.

For the sake of easiness, simplicity and less time consuming we have adopted non probability sampling technique in which convenience sampling the best suited for us.

METHODOLOGY

Section I: System Description

CE-OFDM system

Constant envelope is a modulation format for digital wireless transmission. In this format the electrical of the carrier phase is modulated by OFDM waveform which provides 0db PAPR.

$$x(n) = \sum_{k=0}^{N_{QAM}} R\{x(k)\}\cos\left(\frac{2\pi kn}{N_{DFT}}\right) - j\{x(k)\}\sin\left(\frac{2\pi kn}{N_{DFT}}\right)$$

Where n=0, 1…NDFT-1 and j=√-1

The signal x (n) produced the high PAPR OFDM sequence are passing through a phase modulator to obtain 0db PAPR sequence.
In the constant envelope signal the Information message signal is a real valued OFDM waveform:

$$x(t) = c\sum_{k=1}^{N_{QAM}} R\left\{x(k)\cos\left(\frac{2\pi kt}{T}\right) - j\left\{x(k)\sin\left(\frac{2\pi kt}{T}\right)\right\}\right\}$$

The signal modulates the phase of carrier and the resulting output of the phase modulator is

$$s(t) = A\exp[j2\pi f_c t + \varphi(t)]$$

With the M-QAM data symbols T=N/Fs the signaling interval duration. Fs is sampling rate and C is constant and A is the amplitude of signal fc is the carrier frequency. The phase signal during nth interval is

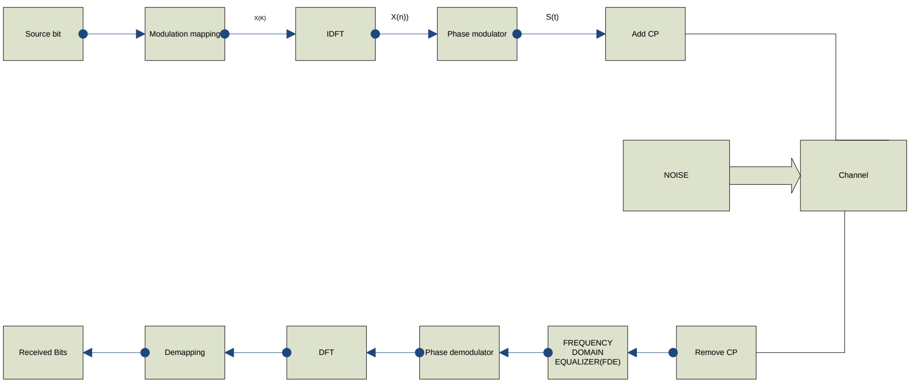

Figure 1: Block diagram of CE-OFDM using phase modulation

In this system we have to give bit sequence as input. By using modulation mapping we generate the symbols. These symbols are then applied to the input sequence of the IDFT block. During each T second block interval, as N-DFT inverse fourier transfer (IDFT) generates sum of orthogonal signal.

$$x(n) = \sum_{k=0}^{N_{DFT}-1} x[k]e^{j\,2\pi kn/N_{DFT}}$$

Where h is the modulation index Cn is a constant which is used to normalized the variance. θn is the initial phase which is used for memory term.to make the modulation phase continuous. The Bandwidth of the signal s(t) is expressed as B=Max(2πh,1) Bw Hz which is the root mean square bandwidth and of the lower bounded by the band width of conventional OFDM which is depend on the modulation index h. The modulation h plays very important role for bandwidth description and performance of constant envelope OFDM.

In the case of CE-OFDM the cyclic prefix is added to avoid ISI and ICI. At the receiver side cyclic prefix is discarded and the reverse operation is performed.

Section II: Discrete Wavelet Transform Based CE-OFDM

Wavelet transform is a tool which gives the time and frequency localization of a signal simultaneously. Because wavelet transform is capable of providing time and frequency information simultaneously. Hence, it gives the time frequency representation of signal. By using wavelet transform we can reduce the ISI and ICI without the use of cyclic prefix as used in DFT based OFDM or CE-OFDM system In wavelet-based CEOFDM (DWTCEOFDM) the IDFT and DFT blocks are simply replaced by an inverse discrete wavelet transform (IDWT) and discrete wavelet transform (DWT) blocks respectively. In DWT-CEOFDM data modulation and demodulation are done via IDWT and DWT operations. The IDWT signal can be generated by:

$$x[t] = \sum_{m=-\infty}^{\infty} \sum_{k=-\infty}^{\infty} x(k) 2^{m/2} \psi(2^m t - K)$$

To recover the data at the rate 2m Hz the smallest base band bandwidth should be2m+1 Hz. In wavelet based modulation the subcarrier waveforms are obtained through the wavelet transform.

The x (t) signal is passed through phase modulator, the output of the phase modulator is:

$$S[t] = A\exp[j2\pi fct + \omega(t)]$$
$$\omega(t) = 2\pi h\, x(t)$$

A is the signal amplitude and $\omega(t)$ is an arbitrary phase offset which may be used as a design parameter to achieve phase continuous modulation, h is the modulation index.

The processing of a signal through which inverse wavelet transform take place is usually referred to as synthesizing into wavelet coefficients, while the reverse operation is called analyzing from wavelet coefficients. The waveforms constructed through the wavelet transform (WT) are that they are longer than the transform size. Hence, wavelet modulation (WM) belongs to the family of overlapped transform. The waveforms being K-shift orthogonal, the inter-symbol orthogonality is the tree algorithm. The wavelet filter of length L_0 generates M waveforms of length:

$$L = (M-1)(L_0 - 1) + 1$$

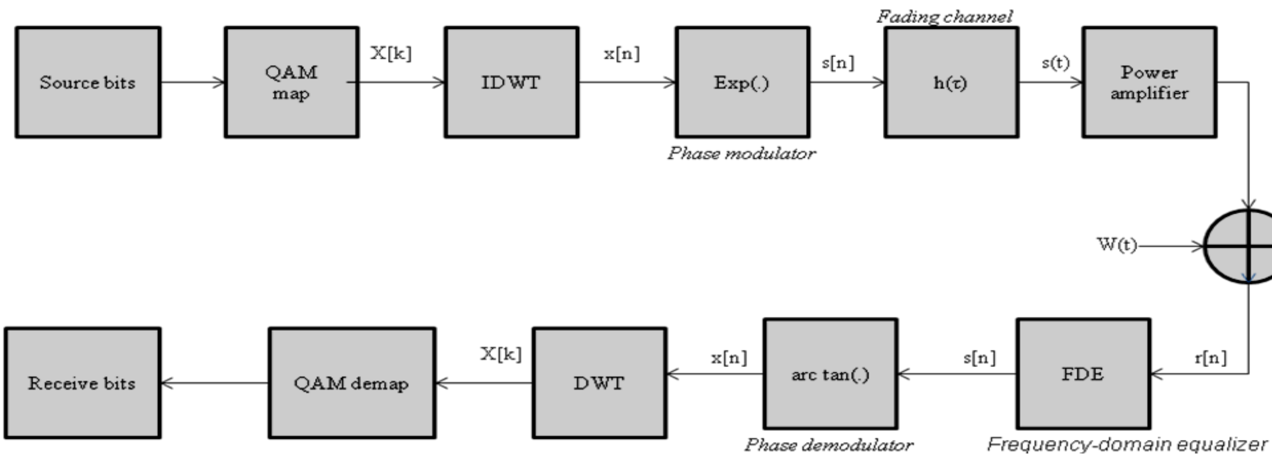

Figure 2: Wavelet based OFDM system Block Diagram

Where, ψ (t) is the wavelet function with compressed factor m times and shifted k times each subcarrier and x (k) is the data that is modulated onto the wavelets at different scales. X (t) is completely specified by x (k), x (k) is the generating sequence for the transmitted signal x (t) and m is a finite set of integers.

RESULT

International Journal of Engineering Management and Life Sciences (IJEMLS)
Volume: 01 Issue: 01 | June-2016 www.ijemls.com

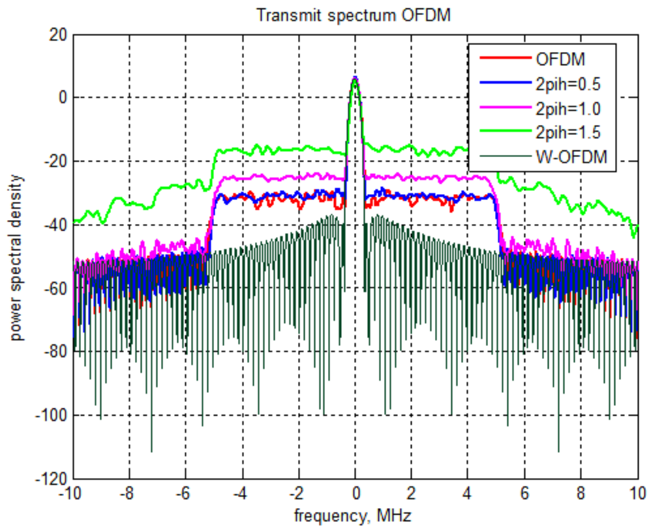

Figure 3: Spectrum of DWT-CEOFDM-PM and FFT-CE-OFDM-PM

The above Fig. 3 shows the power spectral density of CE-OFDM and DWT-CEOFDM using phase modulation. The effective bandwidth of the CE-OFDM-PM is a function of modulation index h. In this Fig. 3 the signal bandwidth depends on the modulation index h. From the above Fig. 3 it has been shown that the DWT based CE-OFDM signal gives the better spectrum performance than CE-OFDM and OFDM signal, because wavelet based system provides the good spectral performance.

The Fig. 4 shows the BER performance of DWT-CEOFDM and CE-OFDM using phase modulation. The BER performance of DWT –CEOFDM is better than the CE-OFDM. The BER performance is 10-3at 21db in DWT-CEOFDM, in CE-OFDM the BER is 10-3 at 23db.

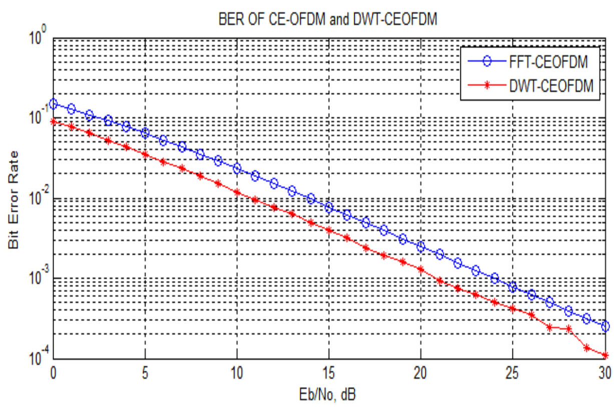

Figure 4: BER of CE-OFDM and DWT-CEOFDM under Rayleigh fading channel

CONCLUSION

In this paper a new PAPR technique has been seen which provide 0db PAPR. The CE-OFDM is implemented with wavelet transform gives better spectrum efficiency than CE-OFDM. The main disadvantage of OFDM and CE-OFDM is that cyclic prefix is added to remove ISI and ICI. But in the case of DWT-CEOFDM there is no need of cyclic prefix. IN this paper also shows that the DWT based CE-OFDM, the spectral performance is much better than FFT based CE-OFDM. The main advantage of using WOFDM is that it is a very flexible system which is also simple, and has a low complexity as only low order filters are needed instead of complex FFT processors. The BER performance is measured under Rayleigh fading channel. The BER performance is improved in case of DWT-CEOFDM than the CE-OFDM.

CONFLICT OF INTEREST: None

REFERENCES

[1] Zou WY, Wu Y (1995). COFDM: an overview. IEEE Trans. Broadcast. 41 (1):1–8.

[2] Umaria KN, Joshi K (2012). 'Comparative Analysis Of BER Performance Of DWT Based OFDM system with Conventional FFT based OFDM system. International Conference On Emerging Technalogy Trends in Electronics Communication and Networking.

[3] Ochiai H, Imai H (2001). On the distribution of the peak-to-average power ratio in OFDM signals. IEEE Trans.Commun. 49:282-89.

[4] Li X, Cimini LJ (1998). Effects of Clipping and Filtering on the Performance of OFDM TEEE Comm. 2(5): 131-33.

[5] Casas EF, Leung C (1991). OFDM for data communication over mobile radio FM channels–part I: analysis and experimental results. IEEE Trans. Commun. 39: 783-93.

[6] Chung CD, Cho SM (1999). Constant-envelope orthogonal frequency division multiplexing modulation. Proc. APCC/OECC. 1:629-32.

[7] Tan J, Stuber GL (2002). Constant envelope multi-carrier modulation. Proc. IEEE Milcom. 1: 606611.

[8] Tsai Y, Zhang G, Pan JL (2005). Orthogonal frequency division multiplexing with phase modulation and constant envelope design. Proc. IEEE Milcom. 4:2658 -64.

[9] Pacheco R, Hatzinakos D (2006). Error rate analysis of phase-modulatedOFDM (OFDM-PM) in AWGN channels. Proc. IEEE ICASSP. IV337-IV340.

[10] Thompson SC (2005). Constant envelope OFDM phase modulation, University of California, San Diego.

[11] Sharma S, Kumar S (2011). BER Performance Evaluation Of FFT-OFDM and DWT-OFDM. Int J Net Mob Tech. 1:3.